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A GERMAN INTRODUCTION TO THE STUDY OF MIMICRY.

Mimikry und Verwandte Erscheinungen. By Dr. Arnold Jacobi. Pp. ix+216. (Braunschweig: F. Vieweg und Sohn, 1913.) Price 8 marks.

THE scope of the work before us is sufficiently indicated by a list of its main sections. A brief general introduction is succeeded by a division of the subject under nine heads:—(i.) Protective Colouring; (ii.) Protective Resemblance; (iii.) Warning Colours; (iv.) Mimicry or Protective Imitation; (v.) The Imitation of Aculeate Hymenoptera, or "Sphecoidie"; (vi.) The Imitation of Ants, or "Myrmecoidie"; (vii.) The Imitation of Beetles; (viii.) Mimicry in Lepidoptera; (ix.) The General Characteristics of Mimetic Lepidoptera. Some of the principal memoirs in the literature of the subject are named in a short list at the end of the volume, but anything like a complete treatment is manifestly impossible in a work of this size.

Protective colouring (Schutzfärbung) and protective resemblance (Schützende Aehnlichkeit) are the terms employed by the author for the two kinds of cryptic colouring which have been called general and special protective resemblance. In the first the animal seems to melt into its surroundings; in the second it resembles some actual object. No mention is made of Thayer's interesting combination of the two principles in animals with a general obliterative colouring upon which are represented the details of the normal environment. Nor is there any reference to the same naturalist's brilliant interpretation of the white under-sides of animals.

The criticism, urged on p. 8, that we do not *know* whether the cryptic appearance is truly advantageous and really exists for the eye of the insect-eater can only be fully met by increased knowledge. In the meantime it is obvious that certain birds do hunt for their prey over tree-trunks that are not swept bare, even after many months of intermittent searching, but still harbour sufficient pupæ to keep up the average numbers of the species. We know too that birds will assemble in order to feed, when insects which must ordinarily be searched for are driven out by a grass fire or by "Driver" ants on the raid. And no one who has watched the pursuit of a cryptically coloured moth by birds in the immediate neighbourhood can doubt that it would have been attacked when at rest if only it had been seen.

The resemblances of the Membracidæ to thorns, bark, &c., is dismissed by the author (p. 15) as examples of "Museum Mimicry," for the very inadequate reason that these Homoptera are "mighty jumpers," and when disturbed "disappear after the manner of the flea." Well-concealed species are generally swift in their movements when they are disturbed. Furthermore, W. A. Lamborn has shown that the dark, bark-like West African Membracids are ant-attended when found on green stems. Companies of individuals are always found on old bark, as are females engaged in egg-laying—a very prolonged operation, lasting from thirty-six to forty-eight hours, during which the insect clings tenaciously to the egg-mass and is with difficulty disturbed (Trans. Ent. Soc., 1913, pp. 494–7). The author admits the wonderfully ant-like appearance of some tropical American Membracids, but rejects an interpretation based on the theory of mimicry because ants run and Membracids jump. The idea of a second line of defence does not seem to have occurred to him; and yet in nearly all the examples he accepts there *is* a second line, depending on powers of flight very different from those of the model.

The author has evidently taken considerable pains in studying the work that has been done in this country and expresses regret that his compatriots have not taken a larger share in it. There is, however, one subject which has escaped him, viz., the power of individual adjustment to the colours of the environment as exhibited by insects. On this power he can find nothing in English except "a meagre experiment . . . on butterfly pupæ"! (p. 25). The present writer is, moreover, bound to disclaim the honour of having influenced some of the names that are here set down—for example, the late Thomas Belt, whom he never had the pleasure of seeing, but to whom, for the "Naturalist in Nicaragua," he owes a deep debt of gratitude. Although the author writes with generous appreciation of British work, and appears to agree with its general tendency, he differs strongly from many conclusions on special points, and offers criticisms which it will be a pleasure to attempt to meet on some future occasion.

It is satisfactory to find the recognition, on p. 35, of a fact often forgotten—"that even the protective adaptation which is apparently the most perfect does not give security against detection—that creatures thus equipped have their special foes which can find them out, at least when driven by hunger." Similarly the polymorphism of the leaf-butterflies, Kallima, &c.—a stumbling-block to many—is clearly explained. "This multiplicity of patterns is the very thing which assists the efficiency of the leaf imitation, since the faded, dried, half-rotten leaf occurs in nature in a thousand forms and colours, with its transition from green to yellow and brown, its slits and jags, its traces of gnawing and of mould and fungi" (p. 37). And the objection, sometimes raised by those who have not sufficiently considered the subject, that a Kallima may be seen resting with expanded wings on green foliage is also effectively answered on p. 39.

For Warning Colours and in other parts of the book the author accepts the terminology introduced in this country in 1890. Haase's term, "Immunity" is wisely used only in a restricted sense. The unqualified word, carrying with it the assumption that the bearers of warning colours are exempt from all attack, even by parasitic foes —an assumption carefully guarded against on p. 52—gives an entirely mistaken impression. That such insects have their special enemies has now been shown by many observers. A good example is the highly conspicuous *Acraea zetes,* of which Dr. G. D. H. Carpenter collected in Uganda seventy pupæ and full-fed larvæ, but only reared sixteen butterflies. All the others—77 per cent. of the whole—were destroyed by parasitic insects.

The theory of aposematic or warning colours is considered to stand on a much firmer foundation than that of cryptic colouring (p. 50); but the author, accepting the conclusions published in the Proceedings of the Zoological Society in 1887, recognises the intimate relationship between the two. "Aposematic species restrict the food available for insect-eaters" and must therefore "pass on to other non-protected species the onus of satisfying the hunger of their foes. Now, if these, by any process of development, also attained immunity, the foe would be compelled to overcome his disgust, and accept the disagreeable food, and thus the advantage of the warning colour as an advertisement would be reversed, for it would facilitate the discovery of the prey" (p. 52).

The treatment of terrifying markings is inconsistent. They are ridiculed on p. 23, but taken seriously on pp. 56–59. It must be freely admitted that markings which make so strong an appeal to the imagination require to be tested and re-tested by carefully observing their effect upon enemies, before the bionomic meaning can be accepted as proved. This can scarcely be claimed at present for any examples except the terrifying Sphinx larvæ, the objects of superstitious fear by man in different countries, and proved by four observers to excite fear in animals. This, the clearest example, is doubted by the author, although he accepts the far more problematical interpretation of the markings and attitude of the eyed hawkmoth (*Smerinthus ocellatus*) as terrifying. Such an interpretation is probably correct, but before accepting it we require at least as much evidence as has been collected for the larvæ.

In the historical account of mimicry a common error is repeated. H. W. Bates himself, in his classical memoir (Trans. Linn. Soc., vol. xxiii., 1862, p. 495), grouped together the phenomena of mimicry and protective resemblance, and did not, as stated on pp. 60, 61, understand the former "as referring only to similarity in form and colour between creatures of different systematic position."

It is well-nigh impossible to get rid of an error of this kind when once it has been fairly started. However, we must do our best. Bates, on pp. 508–10 of his paper, quotes numerous examples of procryptic resemblance to twigs, bark, lichen, the excrement of birds and caterpillars, dewdrops, &c., concluding with the words, on p. 510: "I think it will be conceded that all these various kinds of imitative resemblances belong to the same class of phenomena and are subject to the same explanation. The fact of one species mimicking an inanimate object, and another of an allied genus a living insect of another family, sufficiently proves this." A footnote on pp. 508–9 is even more conclusive; for the actual term "mimicry" is applied to the procryptic examples. Referring to Rössler's interpretation of the buff-tip moth in the resting attitude, Bates adds in a note: "In an article on resemblances between insects and vegetable substances (*Wiener Entomol. Monatschrift,* 1861, p. 164), the author enumerates many very singular cases of mimicry; he also states his belief that the mimicry is intended to protect the insects from their enemies." The convenient restriction of the term mimicry to the resemblances to other specially defended animals—the models—came later, and is due to Wallace.

Returning to the author's section on mimicry, we notice a simple and convenient device for representing the mimetic association between two species, the names being connected by an arrow pointing in the direction of the model.

In the sub-section on "Mimicry among Batrachians" there is an interesting footnote on p. 75, suggesting the specific identity of the conspicuous, distasteful amphibian, which, as the author says, "hops about in all Darwinian literature as 'Belt's Frog.'" The species, he thinks, "can be nothing but *Atelopus varius*, which is extremely common in Central America." My friend, Mr. G. A. Boulenger, however, does not entirely agree with this conclusion. "It is quite possible," he writes, "that Belt's frog was *Atelopus varius*, Stannius, but it is more probable that it was *Dendrobates typographus*, Keferstein (*ignitus*, Cope), which occurs also in Nicaragua. All the *Dendrobates* appear to be very poisonous."

The section on mimicry of ants—one of the most important in the work—is enriched by an excellent summary, on pp. 114–23, of Wasmann's splendid researches.

Vosseler's account of the life-history of the Locustid *Eucorypha fallax* is given at considerable length and illustrated, on pp. 107–12. An ant-like larval stage of this insect was described long ago as *Myrmecophana fallax* by Brunner von Wattenwyl, and it is most satisfactory that Vosseler's excellent observations have now put this often-quoted example of mimicry in its true position. He shows that "after the fourth change of skin" there is "a change from a mimetic to a cryptic appearance," the succeeding stage being leaf-like in colour and exhibiting a correspondingly altered behaviour. The change thus begun continues to the end, the winged imago being beautifully leaf-like. In correspondence with these changes Vosseler does not admit that any feature in the likeness is unnecessary. And yet this was one of the very cases on which Brunner founded his conception of "hypertelic" resemblance, or resemblance that attains an altogether unnecessary perfection in detail—that is, in fact, "too good to be true."

The illustrations, especially those that are coloured, are rather rough, but they are, on the whole, well selected and serve their purpose. It is a pity that the two species of Heliconius figured on pp. 144 and 145 were not accompanied by *Melinaea imitata* and *Mel. ethra*, instead of *Mechanitis doryssus* and *Mech. lysimnia* respectively. If room could be found for only one Ithomaeine, there is no doubt that Melinaea should have been the genus selected. The mimetic females of the African *Papilio dardanus* are so complicated that much care is required to avoid mistakes. It is unfortunate that the only characteristic eastern and south-eastern Danaine model, *Amauris echeria*, and mimetic form (*cenea*) of *dardanus* should be described on p. 163 as West African.

But when every criticism has been urged, we must admit that the book will be very useful. Haase's important monograph is too large and expensive to be likely to reach many hands, and we welcome the appearance of a German work of small price and moderate size, which will serve as an introduction to this interesting and much-debated subject. E. B. P.

TEXT-BOOKS OF CHEMISTRY.

(1) *General Chemistry Laboratory Manual.* By Prof. J. C. Blake. Pp. x + 166. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 8*s*. net.

(2) *Practical Chemistry.* Qualitative Exercises and Analytical Tables for Students. By the late Prof. J. Campbell Brown. Sixth edition. Edited by Dr. G. D. Bengough. Pp. 78. (London: J. and A. Churchill, 1913.) Price 2*s*. 6*d*. net.

(3) *Organic Chemistry for Students of Medicine.* By Prof. J. Walker, F.R.S. Pp. xi + 328. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1913.) Price 6*s*. net.

(4) *Quantitative Analysis in Practice.* By Prof. J. Waddell. Pp. vii + 162. (London: J. and A. Churchill, 1913.) Price 4*s*. 6*d*. net.

(5) *La Catalyse en Chimie Organique.* By Paul Sabatier. Pp. xiv + 255. (Paris and Liège: Librairie Polytechnique, Ch. Beranger, 1913.) Price 12.50 francs.

(1) THE exercises in this manual are complementary to the author's "General Chemistry: Theoretical and Applied," and accordingly the work can scarcely be recommended to chemical students in general unless they are taking a course very similar to that planned by the author. About one-half of the book, which is interleaved throughout with blank pages for students' notes, is devoted to simple experiments, partly qualitative and partly quantitative, dealing with the chemistry of non-metallic ("acid-forming") elements. The experiments on the metals ("base-forming elements") might serve as an introduction to inorganic qualitative analysis, but would be of slight educational value unless accompanied by a course of lectures on the theory of analysis. A few simple experiments on the atmosphere, the soil, fuels, and oils, natural waters, the ferrous metals, and rocks are grouped under the heading of applied chemistry.

(2) This treatise, like the foregoing manual, is chiefly of interest as affording an indication of the subject-matter chosen for experimental study in the author's practical classes. These exercises are preceded by the following general instruction: "After performing each of the following exercises, the student should record the reactions in his note-book in the form of equations whenever an equation is possible." This excellent instruction, if conscientiously obeyed by the student and carefully supervised by a sympathetic demonstrator, would go far towards making the work educational. Yet without previous knowledge gained either from text-books of general chemistry or from lectures on the theory of analysis, the student